Arizona's Comprehensive Water Quality Monitoring Strategy

For Fiscal Years 2007 to 2017

Prepared by the

ADEQ
Arizona Department of Environmental Quality

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Arizona's Comprehensive Monitoring Strategy
For Fiscal Years 2007-2017

Prepared by the Surface Water Section, ADEQ,
1110 W. Washington St., Phoenix, AZ 85007

Edited by Jason D. Jones

The Arizona Department of Environmental Quality
shall preserve, protect and enhance the environment
and public health, and shall be a leader in the develop-
ment of public policy to maintain and improve
the quality of Arizona's air, land and water resources.

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CHAPTER 1 – MONITORING STRATEGY

The purpose of this document is to provide a vision and strategic direction for ADEQ's water quality monitoring programs in accordance with EPA's *Elements of a State Water Monitoring and Assessment Program* (EPA, March 2003), the Clean Water Act (CWA) and Arizona law. The strategy identifies current monitoring program capacities, deficiencies and resource needs and makes recommendations for implementing ADEQ's monitoring programs over a 10-year period.

The development of a comprehensive monitoring program that adequately implements all of the recommendations of the *Elements* guidance will be a long-term process, which is largely dependent on adequate resources and staffing. ADEQ's strategy will cover fiscal years 2007 through 2017 (Arizona's fiscal year begins on July 1). The strategy is intended to provide a framework for Arizona's monitoring strategy and is designed to be easily changed over time.

The strategy identifies current monitoring program gaps and makes recommendations for filling those gaps and improving ADEQ programs over the next 10 years. Full implementation of the strategy will result in the development of ADEQ monitoring programs that meet or exceed all statutory requirements of the Clean Water Act and Arizona laws related to water quality monitoring.

DOCUMENT ORGANIZATION

This document is organized into 10 chapters. Chapters 1 and 2 discuss general programmatic concepts such as the overall monitoring strategy and monitoring objectives. Chapters 3 through 10 discuss specific elements of the monitoring process. An implementation schedule to reach the goals outlined in Chapters 3 thru 10 is included in the Appendix A. This appendix provides goals, target dates for completion, a strategy for implementation, and resources needed to complete each task.

WHY MONITOR?

ADEQ monitors lakes, streams, wetlands and groundwater throughout the state to gather information. ADEQ uses this information to assess whether the water is safe to drink, safe to swim in, suitable for irrigation, or protective of aquatic life.

Figure 1 illustrates the relationship between water quality monitoring, assessments, Total Maximum Daily Load (TMDL) development, and the implementation of water quality improvement strategies. Water quality is monitored and the results are compared against the surface water quality standards. The results of the assessment are included in the CWA Section 305(b) report, while impaired waters are placed on the 303(d) list. TMDLs are developed for impaired surface waters on the CWA Section 303(d) list. The National Pollutant Discharge Elimination System (NPDES) is a permitting program which addresses point source discharges to surface waters. These permits are written to meet water quality standards to protect water quality and designated uses. Arizona received delegation for this program in December 2002. The Clean

Water Act Section 319 program addresses nonpoint source programs and provides grants for projects to improve water quality

Figure 1. Water quality monitoring is integrated with the development of water quality standards, TMDLs, assessments and the implementation of water quality strategies.

OTHER CONSIDERATIONS

To be effective, Arizona monitoring programs will need to grow with the rest of the state. In 2006, Arizona had a population of approximately 5.9 million people (Figure 2). By 2017 the total population of Arizona is estimated to be between 8 million and 9 million people.

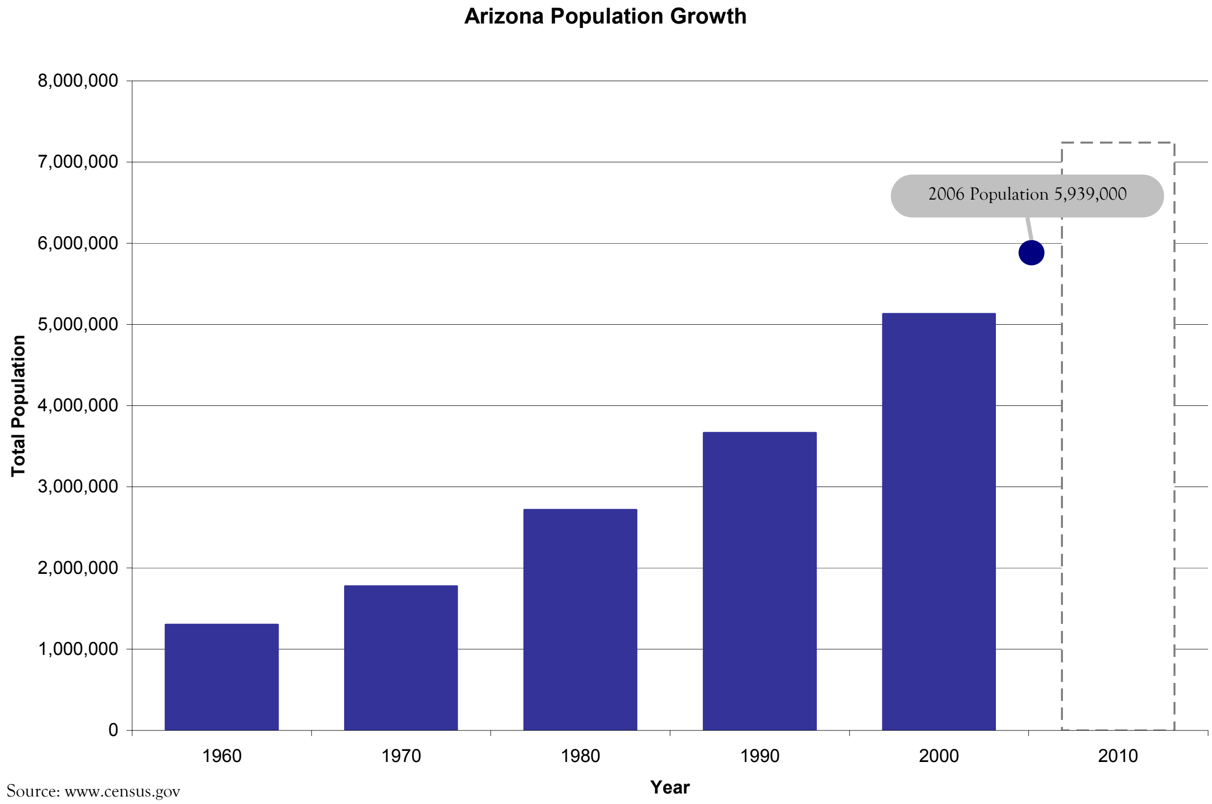


Figure 2. Arizona Population Growth.

Human activities such as mining, agriculture, deposition of mercury from power plants and hydrologic modification can impair streams and lakes in Arizona. As the population continues to increase the impact of human activities on Arizona's water quality will also grow.

WHAT DOES THE STRATEGY COVER?

This strategy addresses the water quality monitoring of rivers and streams, lakes and reservoirs, wetlands, and groundwater in accordance with the Clean Water Act and Arizona Revised Statutes (A.R.S.) § 49-225.

Table 1. An estimate of Arizona's Water Resources (Status of Water Quality in Arizona, 2004).

	Streams (miles)	Lakes (acres)	Wetlands	Groundwater
Non-Native American Land				
Perennial	3,530	168,586	NA	NA
Intermittent	9,365	121,046	NA	NA
Ephemeral	77,480	NA	NA	NA
Native American Land				
Perennial	1,450	18,481	NA	NA
Intermittent	260	11,237	NA	NA
Ephemeral	35,420	NA	NA	NA
Total	**127,505 miles**	**319,350 acres**	**72,322 acres**	**1.85 billion acre feet**[1]

NA = Not applicable

Arizona is an arid state and most of its streams are not perennial. More than 90 percent of the total stream miles located on non-Native American lands in Arizona are intermittent or ephemeral waters. Intermittent waters are defined as waters that flow continuously only at certain times of the year, such as when a stream receives water from a spring or another surface source (like melting snow). Flows in intermittent waters are variable and highly dependent on climactic conditions, which make them difficult to monitor. Continuing drought conditions and reduced winter snow pack at higher elevations in recent years have resulted in many intermittent and perennial waters drying up across the state. Drought conditions make it more difficult for ADEQ to reliably predict whether intermittent streams will have water to sample in any one year.

Ephemeral waters are defined as normally dry water courses that flow only in direct response to precipitation (such as storm water runoff). Ephemeral waters may flow for a few hours or days depending upon the amount of rain. It is difficult to predict when and where flows will occur in ephemeral waters because of Arizona's "flashy" hydrology and the often highly localized and variable nature of storms. Because of the practical difficulties of reliably predicting the presence of water to sample in intermittent and ephemeral waters, ADEQ has chosen to focus its monitoring strategy on the target population of perennial surface waters.

It is estimated that less than one percent of Arizona's landscape has wetlands (National Water Summary on Wetlands Resources, 1996). Arizona's wetlands include riparian wetlands, marshes, oxbow lakes, bosques, cienegas, playas, caldera lakes, and tinajas. ADEQ includes wetlands within its regulatory definition of "surface water" consistent with the inclusion of wetlands within the federal definition of "waters of the United States."

[1] Estimate does not include the Salt watershed and selected basins. (Status of Water Quality in Arizona, 2004)

The following tasks highlight recent wetland related work by ADEQ:

- In the 1990s, ADEQ received a wetlands grant to look at physical integrity to protect riparian corridors,
- ADEQ has created a perennial stream map that uses modeling data from the U.S. Geological Survey (USGS) to more accurately predict stream flow regime (Anning, 2009),
- In 2009, ADEQ received a 104(b) wetland grant to map and monitor wetlands throughout the state, and
- ADEQ is participating in the 2011 National Wetland Survey.

Arizona's wetlands have not been extensively studied and ADEQ has not yet developed water quality standards specifically for wetlands. ADEQ has just begun to develop a monitoring program specifically for wetlands as part of the 104(b) monitoring grant.

WHAT IT DOESN'T COVER

This strategy does not cover monitoring associated with water quality assurance revolving fund/superfund, underground storage tanks or drinking water programs. It also doesn't cover monitoring for water bodies on tribal lands. There are 22 Native American tribes in Arizona and a significant percentage (28 percent) of the land in Arizona is tribal land. ADEQ does not have jurisdiction to conduct water quality monitoring of surface waters located on tribal lands and only conducts such sampling at the express request of a tribe. For this reason, ADEQ does not perform §305(b) water quality assessments of waters located on Native American lands. Some Native American Tribes in Arizona have qualified for treatment as a state under §518 of the Clean Water Act and they administer their own water quality management programs under the Clean Water Act. For example, the Navajo Nation has adopted tribal water quality standards and conducts its own water quality monitoring program.

CHAPTER 2 – MONITORING OBJECTIVES

ADEQ has a variety of objectives for its monitoring programs. These objectives range from big picture questions such as "how does the water quality in Arizona compare to the nation?" to very specific questions such as "how did the 2003 Aspen fire impact surrounding streams?" In general, the objective of a specific monitoring program depends on what kind of questions that need to be answered.

MONITORING OBJECTIVES PRESCRIBED BY ARIZONA LAW

Arizona law prescribes several objectives for ADEQ surface and groundwater quality monitoring programs. A.R.S. §49-225(A) mandates that ADEQ conduct ongoing monitoring of the waters of the state, including Arizona surface waters and aquifers to:

- Detect the presence of new and existing pollutants,
- Determine compliance with applicable water quality standards,
- Determine the effectiveness of best management practices, agricultural best management practices and best available demonstrated control technologies,
- Evaluate the effects of pollutants on public health or the environment, and
- Determine water quality trends.

ADDITIONAL OBJECTIVES

- Determine if waters are impaired or are attaining based on water quality standards,
- Assess outstanding Arizona waters (antidegradation),
- Determine water quality trends,
- Compare data within Arizona,
- Compare data throughout the United States,
- Clean Water Act (CWA) objectives,
  - Establishing, reviewing, and revising water quality standards §303(c)
  - Determining water quality standard attainment §305(b)
  - Identifying impaired waters §303(d)
  - Identify causes and sources of impairment §§ 303(d) and 305(b)
  - Support implementation of water management programs §303, 314, 319, 402, etc.
  - Support evaluation of program effectiveness §303, 305, 314, 319, 402, etc.
- Identify problem areas and areas needing protection,
- Determine the level of protection needed,
- Determine the effectiveness of water projects and programs, and
- Improve coordination with other agencies, states, tribes, and Mexico.

SPECIFIC MONITORING OBJECTIVES

1. STREAMS – AMBIENT MONITORING PROGRAM

The ambient stream monitoring program is a statewide data collection program. The primary purpose of the ambient monitoring is to characterize baseline water quality of perennial, wadeable streams throughout Arizona. ADEQ accomplishes this goal by implementing the following:

A. ADEQ has a cooperative agreement with the USGS to monitor a network of long-term sampling sites on Arizona's large rivers. These sites are sampled quarterly each year. In Fiscal Year 2010, the USGS monitored 10 fixed station sites throughout the state for ADEQ.

B. Arizona uses a probabilistic monitoring design to assess wadeable perennial streams in Arizona. A probabilistic monitoring design allows statistically valid inferences to be made about sites that have not actually been visited. This will be the second statewide probabilistic assessment of Arizona. The first was completed by the Arizona Game and Fish Department and USGS in 2006. Probabilistic monitoring is done on a three-year cycle using the rotating basin approach (Figure 3).

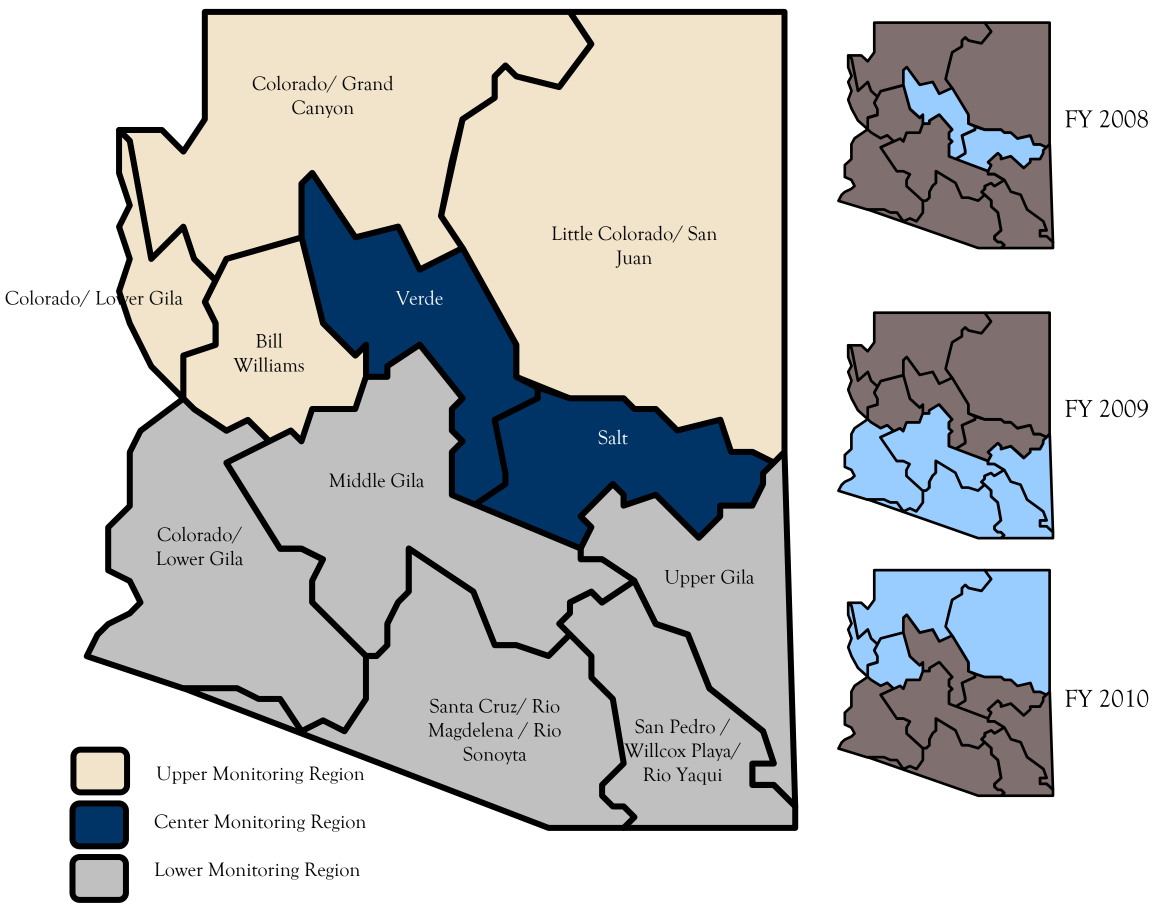


Figure 3. Probabilistic monitoring by region and year.

C. A targeted monitoring design is used in conjunction with the probabilistic design. Targeted sites are selected to address data gaps for reaches identified on the §305(b) Planning List, to monitor Arizona's Outstanding Waters and to investigate complaints.

The specific objectives of the Ambient Monitoring Program are:

- To provide data for the §305(b) surface water quality assessments,
- To provide credible data,
- To identify impaired surface waters pursuant to §303(d) of the Clean Water Act,
- To determine compliance with applicable surface water quality standards,
- To determine water quality trends over time,
- To compare water quality between basins,
- To characterize baseline water quality of wadeable, perennial streams located in selected river basins, and
- To characterize baseline water quality in outstanding Arizona waters and to determine whether water quality is being maintained and protected or is being degraded.

2. STREAMS – BIOCRITERIA PROGRAM

The biocriteria program monitors benthic macroinvertebrates in Arizona's perennial streams. Biological assemblages provide a different picture of water quality than chemical data. Chemical data tends to give a snapshot of what is happening at the time of sample collection, while biocriteria describe how healthy a biological community (for example macroinvertebrates or fish) is over a longer period of time.

The objectives of the biocriteria program are:

- Establish and refine biocriteria standards,
- Assess biological condition of Arizona streams (305b) and identify biologically "impaired waters" (303d) and their stressors, and
- Update reference conditions through ambient monitoring.

3. STREAMS – PHYSICAL INTEGRITY PROGRAM

Sediment is a major pollutant in Arizona streams (Status of Water Quality in Arizona, 2004). ADEQ proposes to conduct stream channel assessments using the concept of natural stream channel stability and associated assessment tools developed by Dave Rosgen in *Applied River Morphology* (1996) to assess the physical integrity of stream channels and to address sediment pollution in Arizona's streams.

The physical integrity of a stream channel means that a dynamic equilibrium in stream channel stability is maintained over time. Dynamic stability which can be defined as the ability of a stream to carry the water and sediment of its watershed while maintaining a stable dimension, pattern, and profile such that, over time, stream channel features are maintained and the stream system neither aggrades nor degrades. Naturally stable streams that have physical integrity, can be described as being in a condition of dynamic equilibrium between erosion and deposition. For a stream to be stable, it must be able to consistently transport its sediment load, both in size and type, associated with local deposition and scour. Stream channel instability occurs when the scouring process leads either to degradation (such as bank erosion, down-cutting) or excessive sediment in the stream results in aggradation (such as sediment deposits and siltation).

The specific objectives of the physical integrity program are to:

- Collect geomorphological data for each stream type and determine which metric(s) correspond best with sediment impaired streams,
- Develop a physical integrity standard based on geomorphological data, and
- Identify stream reaches in the watershed most vulnerable to erosion.

4. LAKES –LAKES PROGRAM

The ADEQ Clean Lakes Program conducts ambient water quality monitoring to determine trophic status and water quality trends in lakes and reservoirs. At the inception of the Clean Lakes Program in 1989, monitoring objectives related primarily to basic water quality characterization and diagnostic / feasibility studies. Since 1991, the Clean Lakes monitoring program has expanded in scope to include research monitoring to develop nutrient criteria for lakes and reservoirs, trophic analyses of lakes and reservoirs, and special water quality investigations (like perchlorate, hexavalent chromium, and bacteria studies). The Clean Lakes Program also is involved in developing TMDLs for impaired lakes and reservoirs listed on the §303(d) list and is participating in the 2012 National Lake Survey (NLS).

Specific Clean Lakes Program objectives are to:

- Characterize lake water quality conditions in relation to watershed conditions,
- Compare Arizona lakes to other lakes in the nation,
- Conduct monitoring to identify potential point and non-point sources of pollutants that may affect lake water quality,
- Provide an organized system to evaluate lake water quality status by identifying natural and anthropogenic conditions affecting lake water quality,
- Develop feasible ways to conserve, protect, and restore lake water quality,
- Develop and maintain a computerized data management system to allow rapid data analysis and provide evaluation of water quality trends,
- Conduct lakes classification and regional studies to support nutrient criteria development, and
- Conduct TMDL research and analysis and submit final TMDLs to EPA for approval for impaired lakes and reservoirs.

5. LAKES AND STREAMS – PRIORITY POLLUTANT / FISH ADVISORY PROGRAM

ADEQ generally follows a strategy recommended by the U.S. Environmental Protection Agency's Office of Water for use in its Priority Pollutant/Fish Advisory Program. The primary objective of the program is to obtain fish tissue data to assess the need for the issuance of a fish consumption advisory. The primary target analyte for the Priority Pollutant / Fish Advisory Program is mercury in fish tissue. ADEQ has issued the following fish advisories:

Table 2. Arizona Fish Advisories.

Fish Advisories for Mercury
Alamo Lake
Coors Lake

Fish Advisories for Mercury
Roosevelt Lake
Lake Pleasant
Arivaca Lake
Peña Blanca Lake
Upper and Lower Lake Mary
Parker Canyon Lake
Lyman Lake
Soldier Lake
Long Lake
Soldier's Annex
Long Lake
Total = 13
Fish Advisories for Pesticides
The Salt and Gila River from 59th Avenue down to and including the Painted Rocks Borrow Pit Lake, and the lower portion of the Hassayampa River
Dysart Drain (canal drains to the Agua Fria River on the west side of Phoenix metro area)
Total = 2

ADEQ implements a two-tiered strategy as the most cost-effective approach for obtaining the data necessary to evaluate the need to issue fish consumption advisories. This strategy consists of:

Tier 1: Screening studies of water bodies where recreational fishing is conducted. Screening studies are to identify lakes and reservoirs where concentrations of mercury in edible portions of commonly consumed fish indicate a potential for significant health risks to human consumers.

Tier 2: Intensive studies of water bodies identified in screening studies to determine the magnitude and geographic extent of contamination in edible portions of commonly consumed fish species. Intensive studies are conducted as follow-up at sites where concentrations of target analytes in tissues were found to be above screening values. Intensive studies are designed to verify the results of a screening study and to identify specific fish species and size classes for which fish advisories should be issued. In addition, intensive studies are designed to provide data for the state risk assessments to refine fish consumption advisories based on intensity of fishing use or vulnerable sub-populations.

Specific priority pollutant / fish advisory program objectives are to:

- Improve the quality of data used by ADEQ for issuing fish consumption advisories,
- Ensure that limited resources of the Priority Pollutant Fish Advisory Program are allocated in the most cost-effective way. The use of screening studies helps to reduce overall program costs by limiting the number of lakes and reservoirs targeted for intensive studies,
- Ensure that data are appropriate for developing risk-based consumption advisories,

- Ensure that fish tissue data are appropriate for determining contaminant concentrations in various size (age) classes of target fish species so that ADEQ can give size-specific advice on contaminant concentrations (as appropriate), and
- Develop a yearly sample and analysis plan to target water bodies where data gaps exist.

6. GROUNDWATER – AMBIENT GROUNDWATER MONITORING PROGRAM

The groundwater monitoring program assesses ambient groundwater quality by groundwater basin. There are 51 groundwater basins in Arizona. Selection of groundwater basins for study are based on a number of factors, including the rotating basin monitoring schedule for surface water and development pressures in basins that may be impacting groundwater quality. As of 2010, ADEQ has completed reports on 19 basins, completed sampling on 17 additional basins and is currently in the process of sampling in two more basins (Figure 4).

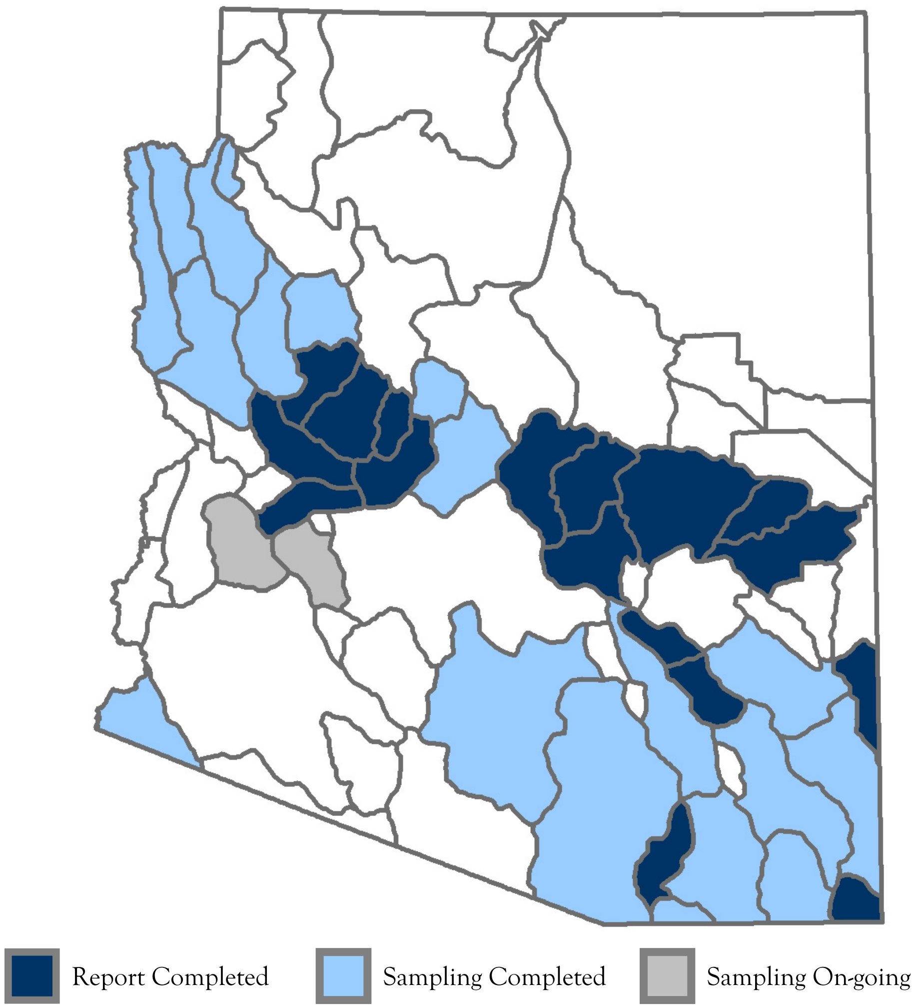


Figure 4. Groundwater basin map.

ADEQ uses the Arizona Department of Water Resource's (ADWR) delineated groundwater basins which are based on physiography, surface water drainages, subsurface geology, and aquifer characteristics. The sampling strategy implemented depends on the characteristics of the basin. The most commonly employed strategy is a systematic, grid-based random sampling which is conducted in selected groundwater basins each water year to determine regional groundwater quality. Using this method, a groundwater basin is divided into monitoring cells depending upon the complexity of the land uses and the hydrogeology of the basin. Existing wells and/or springs are identified and a suitable site is randomly selected in each monitoring cell to represent groundwater quality in that area. Higher density sampling sometimes occurs around targeted land uses to determine the effect of the land uses on groundwater quality. Other strategies that are employed include a stratified random site selection approach in which wells or springs are randomly selected within specific sub-basins such as aquifers or physiographic areas. Sampling is conducted by groundwater basin to examine regional groundwater quality.

Specific groundwater program monitoring objectives are to:
- Determine the suitability of groundwater for drinking water purposes,
- Appraise current baseline groundwater conditions, and
- Examine spatial and temporal groundwater quality patterns.

7. TOTAL MAXIMUM DAILY LOAD (TMDL)

The Total Daily Maximum Daily Load (TMDL) Unit collects data with the cooperation of stakeholders whenever possible to support development of TMDL implementation plans for impaired surface waters in Arizona. The TMDL Unit uses a targeted monitoring design or intensive survey approach to obtain water quality data to characterize impaired surface waters and support the development of TMDLs.

Specific TMDL program monitoring objectives are to:
- Identify sources and causes of pollutant loadings,
- Provide data for water quality models used to calculate wasteload allocations, load allocations, and margins of safety in TMDL analyses,
- Develop TMDLs for the Clean Water Act §303(d) listed water bodies,
- Conduct effectiveness monitoring to assess TMDL implementation success and water quality improvements,
- Develop TMDL implementation plans,
- Conduct TMDL effectiveness monitoring,
- Collect data to calculate Arizona specific wet and dry mercury deposition rates,
- Expand use of automated equipment (sample collection, meteorological, and stream stage) to aid in TMDL development, and
- Expand staff knowledge of narrative water quality standards as their implementation procedures are adopted in order to determine potential sources of impairment.

8. BORDER WATER COORDINATION PROGRAM

ADEQ has played a major support role in the US-Mexico Border 2012 Program. This is a 10-year, binational, environmental program for the U.S.-Mexico border region. The Border 2012 Program is the latest multi-year, binational planning effort to be implemented under the La Paz Agreement and succeeds Border XXI, a five-year program that ended in 2000. Border 2012 provides the venue for U.S. and Mexico binational effort, to achieve a clean environment, protect public health and natural resources, and encourage sustainable development in the border region — a 100-kilometer buffer zone that extends north and south of the US-Mexico border. While the program is implemented by ADEQ, U.S. and Mexican entities work cooperatively towards these goals. The Border Water Coordination Program (BWCP) coordinates with the Surface Water Section and uses federal authority based on Section 106 of the Clean Water Act to address transboundary water quality problems.

The binational water quality and quantity issues between the U.S. and Mexico are under the jurisdiction of the International Boundary and Water Commission (IBWC). Surface and groundwater quality and quantity issues in Mexico are the sole responsibility of the Mexican federal government. The Mexican states have little or no jurisdiction on these matters. On the other hand, both the federal and state governments in the U.S. deal with water quality issues, but water quantity is handled by the states alone. In the past, direct contact between the border states (such as Arizona and Sonora) to exchange water quality and quantity information has been difficult but the process is improving as more interaction is taking place among government agencies, academic institutions, and non-governmental organizations on both sides of the border.

The BWCP is providing technical assistance in the development of wastewater pretreatment programs in the Sonora region (includes sampling of industrial waste streams discharging to sewers or waters of the U.S. and/or Mexico). The BWCP is currently supporting the Sonora Northeast WQ Monitoring Project (includes soil, surface- and ground-water samples), the Nogales Wash PCE Plume (includes groundwater sampling), hydrological and engineering technical support to border wastewater infrastructure projects, and GIS/GPS activities in the border region.

Water quality data has been, and will continue to be, collected and analyzed by both countries using commonly agreed upon sampling methodologies and data quality objectives. The BWCP is primarily a monitoring program as there is no enforcement component to this program. However, if ADEQ, U.S., or Mexican federal standards (or regulatory thresholds) are exceeded, the results are referred to the appropriate regulatory agency and program. Referrals can be made to U.S. and Mexican entities, including an environmental program within ADEQ if the program has jurisdiction over the apparent problem. The data may then have some regulatory implications if it is subsequently used for regulatory decision making.

The specific goals of the border water cooperative program are to:

- Identify deficiencies in the treatment of wastewater. The disposal of untreated effluent, and the inadequate operation, maintenance, and capacity of wastewater treatment plants result in health risks to border communities with growing populations,
- Identify potential contamination to groundwater from point sources due to increased industrial activity on both sides of the border, and
- Compile basic inventory and monitoring information pertaining to water resources.

9. NONPOINT SOURCE PROGRAM

The nonpoint source (NPS) program fulfills the requirements of Section 319 of the CWA by comprehensively providing a framework for agency coordination and cooperation and promoting effective management measures and programs to minimize NPS pollution statewide.

The specific goals of the nonpoint source program are to:

- Identify nonpoint source pollution areas in the state,
- Mitigate or remediate nonpoint source pollution through grants from our Water Quality Improvement Grant Program,
- Coordinate with stakeholders to determine effective ways to minimize NPS pollution, and
- Implement 319 project monitoring to determine water quality related improvements.

CHAPTER 3 – MONITORING DESIGN

CURRENT MONITORING DESIGNS

A monitoring design describes how samples are to be collected and analyzed. ADEQ employs the following monitoring designs for each of its different programs (Table 3).

Table 3. Monitoring design by program.

Program	Design
Streams - Ambient Monitoring	Targeted
Streams - Ambient Monitoring	Probabilistic (rotating basin)
Lakes - Clean Lakes Program – Ambient	Targeted
Lakes - Fish Tissue	Targeted
Groundwater - Ambient Monitoring	Probabilistic
Special Studies (Streams, Lakes, and Groundwater)	Targeted
TMDL (Streams and Lakes)	Targeted
Border Water	Targeted
Nonpoint	Targeted

Each type of monitoring design has advantages and disadvantages. Targeted designs can give specific information about a particular location but are not good for basin or statewide analysis. Conversely, probabilistic designs can address overall water quality for the state, but may not be suited for describing a particular impact. ADEQ integrates targeted and probabilistic monitoring approaches to address varying program objectives.

Arizona has used both targeted and probabilistic monitoring designs to assess streams on a state-wide basis. Figure 5 compares the percentage of the state (not including Native American land) that was assessed using probabilistic methods and targeted methods. Probabilistic monitoring assessed approximately 64 and 66 percent of the state in 2006 and 2011, respectively. Probabilistic monitoring never truly assesses 100 percent of the state because not all target sites can be reached (remote sites, canyons, denial of access). Targeted monitoring gradually increased from 2002 to 2008 due to the increased use of volunteer and external data. In 2008, the targeted monitoring design actually assessed a greater proportion of the state than the probabilistic design.

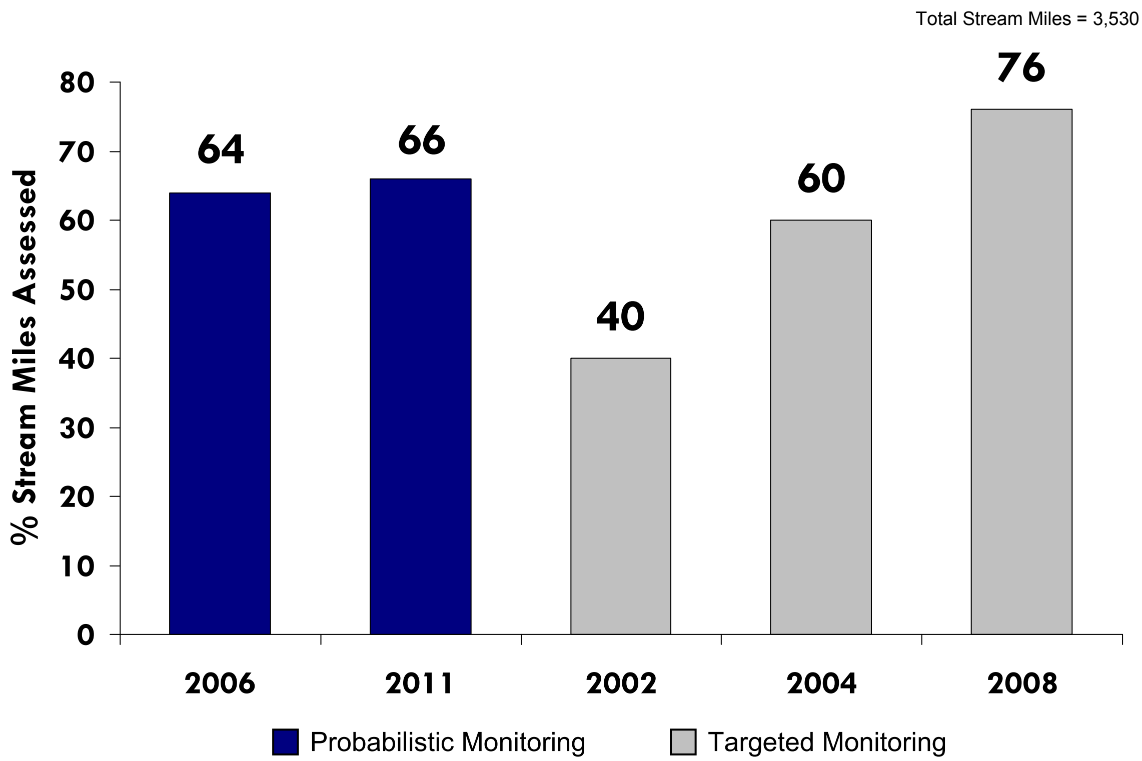


Figure 5. Percent of stream miles assessed state-wide.

Figure 6 compares the 2011 and 2008 probabilistic and targeted monitoring data for macroinvertebrates and core parameters. Core parameters include pH, dissolved oxygen, total dissolved solids and E. coli (see Chapter 4 for more details). Probabilistic monitoring assessed 66 percent of the state for core parameters and macroinvertebrates while the targeted approach only accounted for 53 percent of the core parameters and 33 percent of the macroinvertebrates state-wide.

ADEQ has chosen to continue to use probabilistic monitoring because it better represents core parameters and macroinvertebrates on a statewide basis. ADEQ integrates probabilistic and targeted monitoring by sampling probabilistic sites on a quarterly basis. This enables these random sites to be used in the 305(b) assessment.

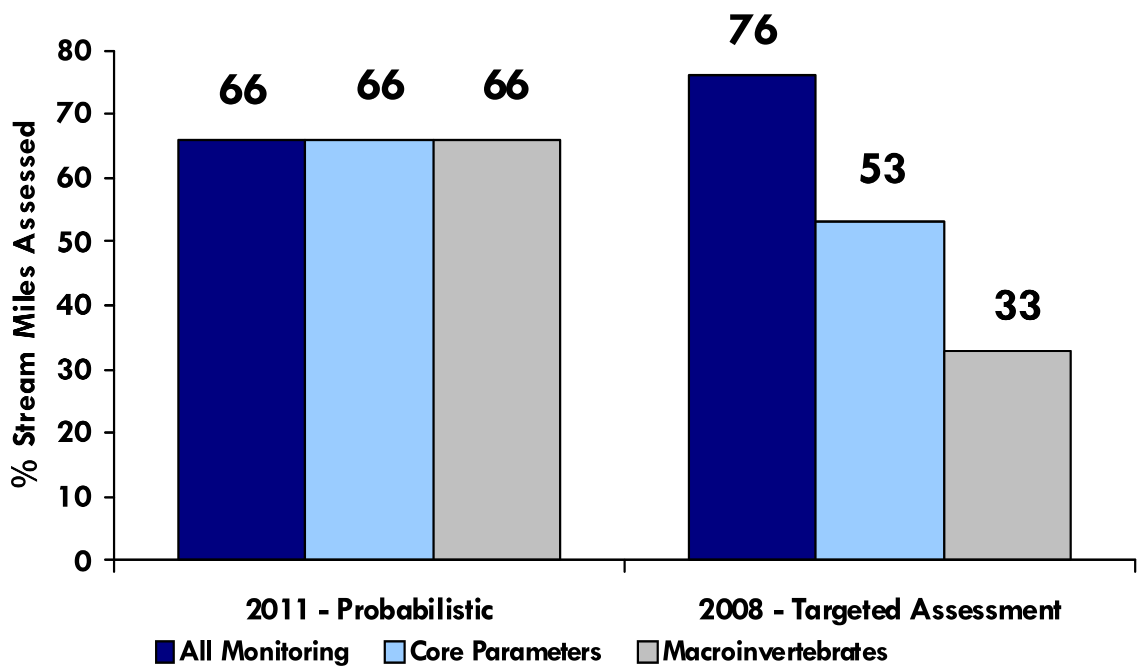


Figure 6. Percent of stream miles assessed for chemistry, core parameters and macroinvertebrates.

FUTURE GOALS

The first part of this chapter outlined how each program is currently functioning. This section describes areas that can be improved in the future. Appendix A gives an implementation schedule for each goal.

#	Goal
1	Conduct additional special studies, such as impacts from wildfires to lakes and streams
2	Coordinate with tribes, states, and Mexico when monitoring and research goals overlap
3	Increase number of samples for the stream, lakes and groundwater programs to improve confidence in data evaluation
4	Monitor wetlands
5	Monitor Effluent Dependent Waters (EDWs)
6	Address assessment data gaps identified on Arizona's 2004 §305(b) report
7	Identify midge specimens to the genus level
8	Increase size of groundwater monitoring program
9	Increase the use of trend analysis in the groundwater monitoring program
10	APP effectiveness monitoring program
11	NPS effectiveness monitoring
12	Use sensors or remote monitoring devices to more efficiently collect data
13	Monitor intermittent streams
14	Monitor the geomorphological condition of wadeable perennial streams

CHAPTER 4 – CORE AND SUPPLEMENTAL WATER QUALITY INDICATORS

One of the key elements in each monitoring program is the selection of water quality indicators to be measured during the water year. Water quality may be characterized by thousands of biological, chemical and physical indicators. The selection of water quality indicators for a monitoring program is based primarily on their relevance to program objectives, the chemical composition of natural freshwater, anthropogenic activities in the watershed, and the probability of water quality standards exceedances.

Generally, all sampling sites are sampled for a basic group of analytes to determine general water chemistry and to assess whether surface or aquifer water quality standards are being met. The basic group of analytes provides data that is typically gathered by most monitoring programs. The basic group includes general chemistry, nutrients, total and dissolved metals, and bacteria. The use of a standard suite of analytes also provides consistency in the amount of data collected across all sampling sites. Additional analytes may be added to the basic group if warranted by site conditions.

ADEQ surface water quality monitoring programs have traditionally focused on the collection of water chemistry and physical data (like discharge, temperature, dissolved oxygen) at sampling sites. Chemical and physical data are important indicators of water quality standards attainment and, as such, are important for §305(b) water quality assessments. Arizona's surface water quality standards rules include numeric, chemical-specific water quality criteria to protect human health and aquatic life. The analysis of the concentrations of specific chemicals in surface water and comparison to adopted numeric water quality standards provide a direct measure of the attainment of the numeric standards. Numeric, chemical-specific water quality standards also lend themselves to calculation of load allocations, wasteload allocations, and margins of safety in TMDL analyses.

A chemical specific approach to surface water quality monitoring is not enough to adequately characterize and assess the condition of Arizona surface waters or to meet the primary objectives of the Clean Water Act to maintain and protect the chemical, biological and physical integrity of the nation's waters. In 2009, ADEQ adopted a new narrative standard for macroinvertebrates in wadeable perennial streams (A.A.C. R18-11-108.01) based Index of Biological Integrity scores.

CURRENT STATUS

SURFACE WATER CORE INDICATORS

ADEQ has chosen the following core indicators for surface water. Each core indicator, for each applicable designated use, must be sampled at least three times during an assessment period and be seasonally distributed to make a full assessment of attainment. ADEQ's selected core parameters for assessment purposes are consistent with EPA's Consolidated Assessment and Listing Methodology (CALM) guidance (EPA, 2002). The CALM guidance recommends that states use a full suite of biological, chemical, toxicity, bacteria, and habitat data to make water quality standards attainment decisions.

Table 4. Core parameters.

Designated Use	Parameters
Aquatic and Wildlife	Dissolved oxygen, flow (if a stream), depth (if a lake), pH, turbidity, total nitrogen, dissolved metals (specifically copper, cadmium, and zinc) and hardness
Fish Tissue	Total mercury
Body Contact	Escherichia coli, pH, metals
Domestic Water Source	Nitrate / nitrite or nitrate, pH, fluoride, and metals (Total arsenic, chromium, and lead)
Agriculture Irrigation	Total boron and manganese, pH
Agriculture Livestock Watering	Total copper and lead, pH

GROUNDWATER CORE INDICATORS

One of the key elements in the design of a groundwater quality monitoring program, whether the program is focused on background monitoring, regional aquifer characterization, impacts of land uses on groundwater quality, or compliance monitoring, is the selection of the indicators to be measured. Groundwater quality may be characterized by thousands of indicators. The selection of indicators for a groundwater quality monitoring program should be based on their relevance to important water quality issues, such as human health protection.

The groundwater monitoring program obtains samples for Safe Drinking Water Act (SDWA) inorganic analysis at each groundwater sampling site. Samples for volatile organic compounds (VOCs), pesticides on the Groundwater Protection List, banned pesticides, radionuclides, bacteria, perchlorate, and others are also collected in areas where these parameters are likely to be encountered. Samples for oxygen, hydrogen, and nitrogen isotope analysis are collected at certain sites to assess groundwater recharge. In the Pesticide Contamination Prevention Program, a series of monitoring wells is constructed in strategic locations characterized by intense agricultural activities and shallow groundwater tables. These monitoring wells are sampled on a regular basis for selected pesticides that are on the Groundwater Protection List (GWPL).

SUPPLEMENTAL INDICATORS

ADEQ identifies supplemental indicators on a case-by-case basis when there is a reasonable probability that a specific pollutant may be present in a watershed, when core indicators indicate impairment, or to support special studies.

FUTURE GOALS

#	Goal
1	Develop narrative standard implementation procedures for toxics
2	Monitor for emerging contaminants
3	Add a second biological assemblage for stream assessments
4	Compare and assess Arizona indicators compared to other states, tribes and Mexico
5	Refine and expand narrative standards for nutrients and bottom deposits

CHAPTER 5 – QUALITY ASSURANCE

Quality monitoring data is essential to each of the water quality programs at ADEQ. ADEQ has developed a Quality Assurance Program Plan (QAPP) to assure quality at each step in the monitoring process (ADEQ, 2007). A draft QAPP was submitted to EPA for review in 2007. Figure 7 illustrates the role of the QAPP during the monitoring process. The QAPP addresses reconnaissance, the sample plan, monitoring and data quality assessment.

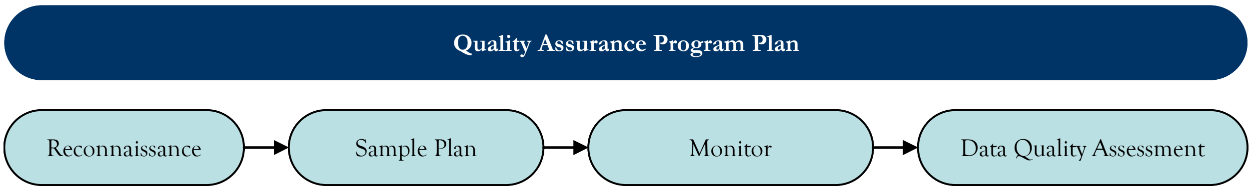


Figure 7. Monitoring Process.

The effective implementation of ADEQ's quality system for the state water quality monitoring programs should result in several benefits, including:

- Scientific data integrity: ADEQ will produce data of known and documented quality based on sound scientific principles,
- Reduced cost: ADEQ program expenditures can be reduced if information needs are more closely matched to data collection by ADEQ water quality monitoring programs. Through proper planning, only the correct type, amount, and quality of data will be collected for use by ADEQ water quality program managers,
- Proper evaluation and assessment: The ADEQ quality system provides documentation and oversight of monitoring activities which allows errors to be identified and reduced,
- More reliable and defensible decisions: When data quality is known and documented, it is easier to determine whether the data can be used for a specific decision. ADEQ will make better decisions and reduce the potential for legal or technical challenges to water quality assessments, §303(d) listings, and permit appeals if an effective quality system is in place, and
- Continuous improvement: The implementation of an ADEQ quality system helps to create a culture of continuous improvement which will lead to additional monitoring program improvements over the next ten years.

CURRENT STATUS OF THE ADEQ QUALITY SYSTEM

The ADEQ quality system is the means by which the Water Quality Division manages and assures quality in its monitoring in an organized and systematic way. The ADEQ quality system provides a framework for planning, implementing and assessing work performed by ADEQ staff and for carrying out quality assurance (QA) and quality control (QC) activities.

EPA requires compliance with American National Standards Institute / American Society for Quality (ANSI / ASQ) specifications and guidelines for quality systems for all recipients of funds for projects involving environmental data collection (such as §106 grant funds). The ANSI ASQ standards for quality systems were developed to promote consistency among the many quality systems for environmental programs at all levels of government and in the private sector. The

ANSI/ASQ standard describes the minimum elements that should be in place to ensure that a functional quality system exists for organizations engaged in environmental data collection. Required documentation for ADEQ includes:

- Documentation of an agencywide quality system (provided in the 1999 Quality Management Plan). An updated Quality Management Plan is currently in the peer review process at ADEQ, and
- Documentation of the application of quality assurance and quality control activities at the specific program level or project level (provided in the 2007 Quality Assurance Project Plan)

ADEQ has both of EPA's minimum required elements for quality systems in place, including an ADEQ Quality Management Plan and a Quality Assurance Project Plan.

ADEQ QUALITY MANAGEMENT PLAN

ADEQ's Quality Management Plan (QMP) was finalized in 1999 in accordance with the requirements of EPA Order 5360.1 entitled "Policy and Program Requirements for the Mandatory EPA Quality System" and EPA guidance entitled "Requirements for Quality Management Plans" (EPA QA / R-2). The QMP describes the agencywide quality management system. The QMP contains a description of the quality management policies and procedures to be employed agencywide to ensure that ADEQ programs involved in environmental data collection produce results of known quality and the data obtained are of the type and quality needed and expected for their intended uses.

The QMP establishes a foundation for implementing effective quality assurance / quality control programs within ADEQ. At a minimum, the QMP is intended to cover all monitoring programs involving the generation of environmental data by programs that are funded by EPA.

The QMP is implemented largely through the following activities:

- Mandated use of Quality Assurance Program Plans (QAPPs),
- Mandated use of Quality Assurance Project Plans,
- Clearly defined QA/QC roles and responsibilities,
- Periodic quality management system reviews and technical system audits, and
- A quality assurance forum to focus on continuous improvement of QA/QC policies and procedures.

Quality Management Plan (QMP)	**Addresses "big picture" quality issues for the Department**
Quality Assurance Program Plan (QAPP)	**Addresses specific quality issues for a program**
Sampling & Analysis Plan (SAP)	**Addresses where, when and what to sample**
Standard Operating Procedures (SOPs)	**Addresses how to sample**

Figure 8. Common Quality Assurance acronyms and what they mean.

The QMP articulates an agencywide quality assurance policy grounded on the following general principles:

- All programs generating, using, or requiring the collection of environmental data will follow the requirements outlined in the QMP or subsequent revisions to ADEQ quality assurance policies and standard operating procedures (SOPs),
- The objectives for generating environmental data will be determined prior to data collection activities so that appropriate resources can be allocated and quality assurance / quality control procedures can be implemented to ensure a level of data quality commensurate with the intended use(s) for the data,
- Each program that generates environmental data will develop and implement a Quality Assurance Program or Project Plan. SOPs will specify in detail how environmental data is to be obtained to assure generation of quality data. Program plans shall be prepared by each division within ADEQ (including the Water Quality Division) and/or by the individual monitoring programs,
- Environmental data generated by ADEQ programs shall be of known and documented quality, as defined by pre-established data quality objectives (DQOs). The process of defining DQOs should be accomplished by ADEQ monitoring programs through a systematic planning process that is consistent with EPA's "Guidance for the Data Quality Objectives Process," EPA QA/G-4 (September,1994), or the most recent version of that guidance, and
- Regular technical audits (TSAs) may be conducted by the ADEQ QA / QC Unit to determine compliance with ADEQ Quality Management System requirements. Additionally, the QA / AC Unit may conduct periodic management system reviews (MSRs). Any deficiencies in QA / QC policies, procedures or implementation identified through TSAs or MSRs will be addressed in a timely manner.

Data quality objectives (DQOs) are quantitative or qualitative statements that clarify the purposes of ADEQ data collection operations, define the appropriate type of data to collect, and specify acceptable levels of decision error. DQOs provide the context for understanding the purposes of the data collection effort and they establish the criteria for assessing the quality of any data set for its intended uses. DQOs also include data quality indicators that specify limits of precision, bias, and accuracy of environmental measurements, the completeness of data sets, representativeness of data, and minimum data validity requirements. ADEQ includes DQOs in annual sample plans for each program.

QUALITY ASSURANCE PROGRAM PLANS

The QAPPs provide the blueprint for monitoring staff on how to apply quality assurance and quality processes to their data collection and management operations to assure that sample results are of the quantity and quality needed and expected by ADEQ water quality program managers and the larger community of water quality data users. The Surface Water Section currently uses two QAPPs.

The 2007 Surface Water QAPP covers the following programs:

1. Ambient Stream Monitoring
2. Ambient Lake Monitoring

3. Biocriteria
4. Priority Pollutant / Fish Advisory Program
5. Total Maximum Daily Load

The 1991 QAPP covers groundwater monitoring (ADEQ, 1991).

The 2007 QAPP was prepared according to EPA guidance provided in EPA Requirements for Quality Assurance Project Plans, EPA QA / R-5, U.S. Environmental Protection Agency, Quality Staff (EPA, 2002). Each QAPP consists of four groups of elements covering ADEQ data operations from planning through implementation to assessment. These four groups are:

1. <u>Program management</u>. The elements of this group address the area of program management, including the history and background of ADEQ monitoring programs, data quality objectives, the roles and responsibilities of staff, staff development and training, and record-keeping.
2. <u>Data generation and acquisition</u>. The elements of this group address all aspects of ADEQ monitoring programs from sampling design to implementation. Proper implementation of the elements of this group ensure that appropriate methods for sampling measurement, analysis, data collection or generation, data handling, and QA/QC activities are employed and properly documented.
3. <u>Assessment and oversight</u>: Elements in this group address activities for assessing the effectiveness of the implementation of ADEQ monitoring programs and associated QA/QC procedures. The general purpose of the assessment is to ensure that QAPPs are properly implemented.
4. <u>Data validation and usability</u>. The elements in this group address the quality assurance activities that occur after the data collection phase of the monitoring program is completed. The implementation of these elements ensures that data conform to specified criteria, thus achieving monitoring program objectives.

The QAPPs are living documents. That is, while individual QAPPs are considered valid for up to five years, they may be revised, in whole or in part, at any time during their five-year terms, as necessary.

STANDARD OPERATING PROCEDURES

Standard Operating Procedures (SOP) provide a basic foundation for how to monitor. SOPs have been developed for the following programs.

Table 5. Standard Operating Procedures by program.

Program	SOP Document Title
Streams – FSN/ Rotating Basin Monitoring	Standard Operating Procedures for Surface Water Quality Sampling (Jones, 2010)
Streams – Biocriteria	Standard Operating Procedures for Surface Water Quality Sampling (Jones, 2010)
Lakes – Clean Lakes	Standard Operating Procedures for Surface Water Quality Sampling (Jones, 2010)

Program	SOP Document Title
Groundwater	Quality Assurance Program Plan (1991), Field Manual for Water Quality Sampling (1995).
TMDL	Standard Operating Procedures for Surface Water Quality Sampling (Jones, 2010)

ARIZONA'S CREDIBLE DATA LEGISLATION

The Arizona Legislature enacted laws governing the implementation of a Total Maximum Daily Load (TMDL) program The TMDL statutes were added by Laws 2000, Ch. 162, §1, effective July 18, 2000. Arizona law now prescribes credible data requirements that have a significant effect on the operation of ADEQ monitoring programs. A.R.S. §49-232(B) requires that ADEQ consider "only reasonably current credible and scientifically defensible data" when making a determination to list a surface water as impaired under §303(d) of the Clean Water Act. The results of water quality sampling are considered to be credible and scientifically defensible data only if ADEQ determines that appropriate quality assurance and quality control procedures were followed and documented in collecting and analyzing the data, that the data are representative of water quality conditions at the time the data is collected, that data consists of an adequate number of samples based on the nature of the water in question and the parameters being analyzed, and the methods of sampling and analysis (including analytical, statistical, and modeling methods) are generally accepted and validated in the scientific community as appropriate for use in assessing water quality conditions.

State law requires that the ADEQ rules specify minimum data requirements and quality assurance / quality control requirements for data to be used in §303(d) listing or de-listing decisions. These rules also must specify appropriate sampling, analytical, and scientific techniques that ADEQ may use in assessing whether a surface water is impaired. ADEQ must specify in the rules the statistical or modeling techniques that ADEQ will use in assessing whether a surface water is impaired. Finally, the ADEQ rules must specify the criteria for including or removing a surface water from the §303(d) list of impaired surface waters (See A.R.S. §49-232(C)). Arizona is currently revising the Impaired Waters Identification Rule.

FUTURE GOALS

Goals complete.

COMPLETED GOALS

#	Completed Goal
1	Draft a QAPP that covers all Surface Water Sampling

CHAPTER 6 – DATA MANAGEMENT

CURRENT STATUS

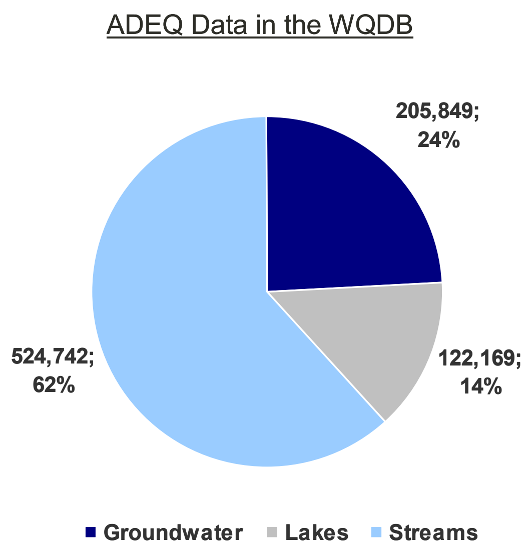
Data management is a critical function both in preserving information and making that information available. The data management process has four main steps.

1. Acquisition of data includes collection of data and entry into a database system by
   A. Manually entering field and/or laboratory data
   B. Electronic uploads from the laboratory and
   C. Downloads from data loggers,
2. Storage of data, including manual and computerized technologies,
3. Validation of data, including error checks and tests of reason applied to concentration values, and
4. Data analysis using statistical software, query tools, database custom reports, and Geographic Information Systems.

ADEQ uses a variety of databases to store water quality data (Table 6). The vast majority (92 percent) of the data is stored in an Oracle database called the Water Quality Database (WQDB). As of 2008, ADEQ had almost 1 million records in the WQDB (Figure 9). An example of a single record would be *E. Coli* collected at site LCLCR211.53 on 8/25/07 with a result of 211 CFU/100 mL. Macroinvertebrate and habitat data make up 8 percent of the total monitoring data and is stored in a separate database called the Ecological Data Application System (Figure 9). ADEQ adds roughly 30,000 records per year while USGS adds roughly 10,000 records per year to the database (mostly through the cooperative agreement with ADEQ). External data has recently been utilized for the 305(b) assessment and currently equals or surpasses the number of records collected by ADEQ (Figure 10).

Table 6. Data management methods by program.

Program	Data Management Method
Streams - Fixed Station Network	WQDB
Streams - Rotating Basin Monitoring Program	WQDB
Streams – Biocriteria	EDAS (Access Database)
Lakes - Clean Lakes Program – Ambient	WQDB
Lakes - Clean Lakes Program – National Lake Survey	WQDB
Lakes – Fish Tissue	Excel Spreadsheets
Groundwater - Ambient Groundwater	WQDB
TMDL (Streams and Lakes)	WQDB, Excel spreadsheet
Border Water	WQDB
Nonpoint	WQDB/Grant Reporting and Tracking System
Assessments	AZAC, ADB



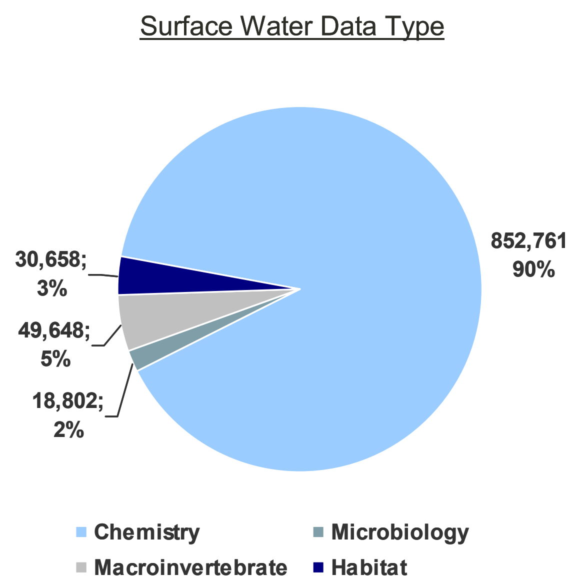


Figure 9. **Number of groundwater, lake and stream records in the database (left) and number of chemistry, macroinvertebrate, microbiology, and habitat records in the database (right) from 1987 to 2008.**

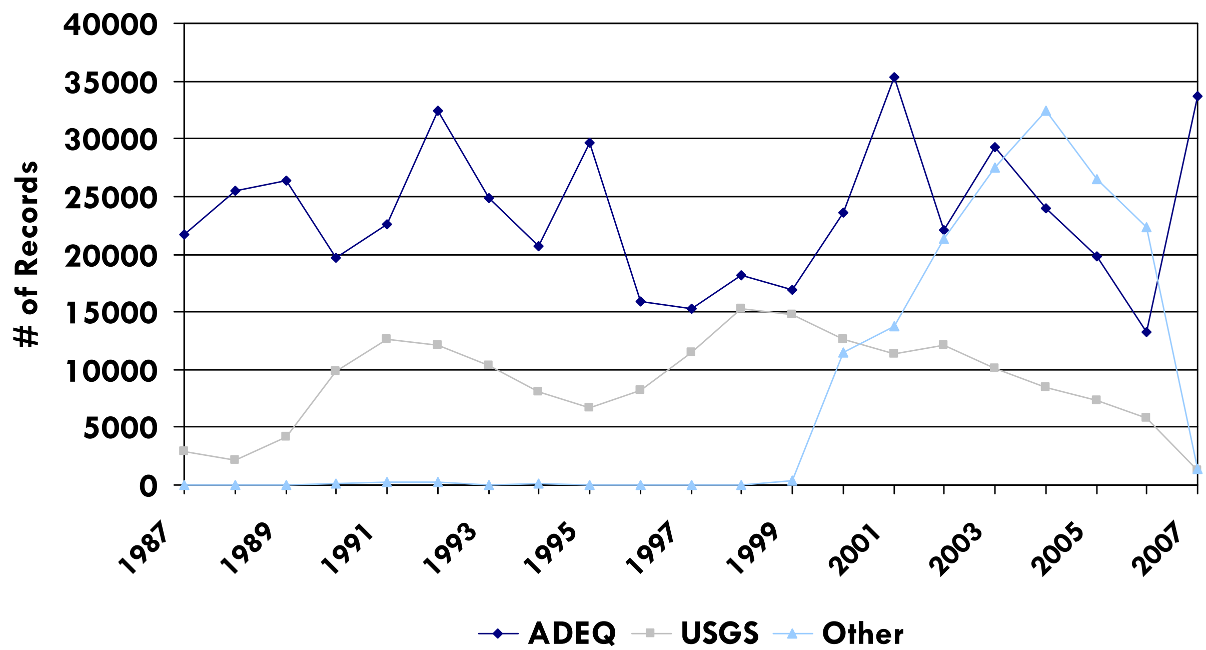


Figure 10. **Number of WQDB records for ADEQ, USGS and External Data.**

The WQDB provides a comprehensive repository for surface and groundwater chemistry data collected by ADEQ and by other monitoring organizations. The surface water portion of the database stores sampling site information, field observations and measurements, and sampling results. The groundwater portion of the database provides a comprehensive repository for well location information, well construction details, field measurement data, and groundwater quality sampling results.

Biological data is stored in the Ecological Data Application System (EDAS). EDAS incorporates a range of functions from relational storage of data to calculation of metrics to the creation of export files (including the creation of formatted batch files to take advantage of STORET's upload capabilities). EDAS was created by Tetra Tech Inc. in 1998 in conjunction with the development and testing of a biological index for warm water streams of Arizona.

The agency is committed to continuous improvement in the way data are generated, compiled, stored and disseminated. In 2009, ADEQ developed a data warehouse system to allow staff to easily query the database.

UPLOADING DATA TO EPA

In the past, ADEQ uploaded monitoring data from the Water Quality Database (WQDB) data to EPA's STORET database annually by going to Salt Lake City once each year. Beginning in 2006, ADEQ uploaded data from the WQDB via a web loading system called the Web STORET Input Module (WebSIM).

In 2009, ADEQ was awarded an exchange network grant from EPA to load data into the Water Quality Exchange (WQX). WQX is a new framework that makes it easier for states, tribes, and others to submit and share water quality monitoring data over the Internet. States, tribes and other organizations can now submit data directly to the publicly accessible STORET Data Warehouse using the WQX framework. The STORET Data Warehouse will continue to be the repository for all modern STORET data and will now also be the new home for data submitted through WQX. WQX will eventually replace the STORET Database (including the STORET Data Entry Module, Reports Module, and STORET Import Module or SIM) as the primary means of submitting water quality monitoring data to EPA.

ADEQ is currently working on submitting data to WQX through the agency node with the help of the exchange network grant. Once the database schema is mapped ADEQ will be able to send data to WQX automatically.

EPA ASSESSMENT DATABASE

Arizona Assessment Calculator (AZAC) is a computer module developed for ADEQ by Tetra Tech, Inc. to help automate assessments of data housed in ADEQ's database. In Phase I, the data was aggregated into seven-day intervals per site, data reliability issues were flagged, and exceedances of surface water quality standards were determined. Reports derived by AZAC were used for the first time in the 2006/08 assessment. Later phases are proposed to take the assessment process further, ultimately automating assessment reports.

Electronic Assessment Reporting to EPA – After the EPA approves the final 303(d) list, ADEQ enters the assessments into a federal Assessment Database (ADB). This provides an electronic version of the assessment report, which is compiled by EPA with other state reports to create the national report to Congress on the status of water quality. Assessments are recorded for each designated use. Pollutants/stressors causing impairment and probable sources are identified for all impaired waters. The status of TMDL development is also tracked in this database to develop national statistics.

ADEQ also sends a Geographic Information System (GIS) cover of the assessed waters to EPA with its electronic assessment. The new National Hydrography Dataset (NHD) is now being used to define the geographic location of assessment units. Attributes in the NHD, such as a reach number and the stream code abbreviations, are also used in ADEQ's Oracle database to identify the sites and surface waters.

OUTSIDE DATA

Data collected by outside agencies is incorporated into the database in order to be assessed using the newly developed AZAC automated assessment program (Figure 10).

FUTURE GOALS

#	Goal
1	Define the geographic location of assessment units using the National Hydrography Dataset (NHD)
2	Follow data standards for digital geospatial metadata to label geospatial datasets
3	Develop a data entry portal for outside data to be entered for assessment purposes
4	Develop modules within WQDB to house time series data
5	Update and enhance AZAC

CHAPTER 7 – DATA ANALYSIS/ASSESSMENT

CURRENT STATUS

Every two years, ADEQ is required by the federal Clean Water Act to conduct a comprehensive analysis of water quality data associated with Arizona's surface waters to determine whether state water quality standards are being met and designated uses are being supported.

The surface water quality assessment process can be summarized as a six-step process as follows:

1. Assemble all readily available monitoring data and water quality related information. Determine whether the data meets requirements under the state's Impaired Water Identification Rule to be reasonable, current, credible, scientifically defensible, and representative of water quality conditions in the surface water.
2. Determine the applicable designated uses and related numeric and narrative standards.
3. Analyze the data, determine whether there is sufficient data for assessments, and assess each designated use.
4. Assess the surface water, placing it in the appropriate assessment category, and on the 303(d) List if a TMDL is needed. A brief summary of each category is listed below. Additional detail regarding each category can be found in ADEQ's 2006/2008 Assessment Report.
   - Category 1: Attaining all designated uses,
   - Category 2: Attaining some designated uses, and no use is threatened or impaired,
   - Category 3: Insufficient or no data and information to determine if any designated use is attained,
   - Category 4: Impaired or threatened for one or more designated uses but a TMDL is not necessary because:
     - 4A: A TMDL has already been completed,
     - 4B: Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard,
     - 4C: The impairment is caused by pollution but not a pollutant, or
     - 4N: The impairment is solely by natural conditions (an Arizona list only), and
   - Category 5: Impaired or threatened for one or more designated uses by a pollutant, and a TMDL needs to be developed or revised.
5. Determine monitoring priorities based on data gaps, needs for TMDL development, and effectiveness monitoring.
6. Provide public review of the draft integrated assessment and 303(d) listing report and revise the report as appropriate.

Water quality assessments are part of an interwoven set of water quality protection and improvement programs at ADEQ. The assessment process compares monitoring data to standards, identifies impaired waters, indicates where additional monitoring should be targeted, and initiates the TMDL loading analysis process. Site-specific standards can be set during TMDL development when natural background levels are higher than standards. These site-specific standards and monitoring collected in support of the TMDL as considered in the next assessment.

ADEQ also works with watershed groups and interested parties to develop plans to implement actions so that surface water quality standards will be met. Grants are awarded to fund water quality improvement projects to mitigate or eliminate nonpoint sources of water pollution. The results of effectiveness monitoring following these projects is used during the next assessment cycle.

Permit discharge limits or enforcement actions can occur based on assessments of ambient data and TMDL development, although this rarely occurs. Permittees may be asked to do additional monitoring when an assessment unit is listed as impaired to provide a scientific basis for modeling loading contributions from the discharge. This data is also included in the next assessment cycle.

The assessment is therefore acting as an evaluation of the other water quality protection programs, and a catalyst for focusing monitoring resources and, if necessary and appropriate, taking enforcement actions.

ARIZONA'S IMPAIRED WATER IDENTIFICATION RULE

Arizona developed the Impaired Water Identification Rule Arizona Administrative Code R11-18-601 through 606) in 2002. These rules establish methods and criteria to:

- Identify an assessment unit as impaired,
- Determine when an assessment unit is no longer impaired (delisting),
- Prioritize the development of Total Maximum Daily Loads,
- Determine whether a dataset is "credible," and therefore, used for assessments and TMDL development,
- Specify general data interpretation requirements,
- Apply a weight-of-evidence approach, that considers contextual information regarding conditions when and where the samples were collected, and
- Determine the spatial extent of the surface water listing.

The Impaired Water Identification Rule is currently being revised to improve consistency with federal listing guidance, and to be based on best available science and statistics.

DATA SOURCES

Monitoring data used in assessments come from a variety of sources: ADEQ's field staff, federal agencies, state agencies, permitted discharge facilities, and even volunteer monitoring groups. Because the objective of collecting the data and data quality varies, ADEQ reviews all readily available surface water quality related data, determines if it meets credible data requirements in the Impaired Water Identification Rule, and uses the scientifically supported data for assessment determinations.

Before each assessment, water quality related data is requested from federal and state agencies, permitted dischargers, universities, and volunteer groups who routinely collect water quality related data. The STORET database is also queried. (STORET is EPA's storage and retrieval system for housing surface water data from federal and state agencies.)

ADEQ encourages the submittal of such water quality data from the general public, other agencies, and permitted dischargers throughout the year. When submitted, other pertinent information should be provided, such as: site locations, sampling and quality assurance plans, monitoring purposes, field observations, and lab notations.

To be considered in the assessment and listing process, data from agencies and other entities must be received by the applicable deadline. Entities are encouraged to submit the data well in advance of these dates to allow ample time for a review of the data and an opportunity to correct errors or supply supplemental information that may be needed. Data also needs to be submitted in an electronic format that can be readily uploaded into ADEQ's database.

Water quality related data includes, but are not limited to: water chemistry, contaminated sediments, bacteria, algae, bioassessments, fish tissue concentrations, fish kills, weed harvesting, physical habitat, beach closures, drinking water advisories, and riparian conditions. Although ADEQ cannot use narrative, bioassessment, physical habitat data, and other qualitative data for a listing decision until appropriate implementation procedures are adopted, such information is considered as "weight-of-evidence" during a listing decision, and has been used by EPA as evidence of impairment. In 2009, ADEQ adopted implementation procedures for bottom deposits and biocriteria.

Any inherent bias in the data is considered when evaluating the data using a weight-of-evidence approach. For example, if the monitoring objective was to establish pristine/reference conditions, exceedances should be rare, and if present they are more likely due to natural conditions. Whereas, if the objective was to determine the effectiveness of watershed improvements, the parameters that exceeded standards in the past are more likely to still be occurring.

FUTURE GOALS

#	Goal
1	Develop criteria and guidance to include volunteer monitoring results in assessments

CHAPTER 8 – REPORTING

With recent budget shortfalls, monitoring programs are funded primarily with federal monies. ADEQ must report an accounting for the money used to run the various programs. ADEQ also generates reports to inform the public about water quality issues in the state.

CURRENT STATUS

ADEQ produces the following reports for the EPA

- 305(b) Integrated Report,
- 303(d) list,
- 104(b) wetlands grant report,
- 106 monitoring grant report,
- Quarterly exception reports,
- Annual 'report card',
- TMDL Reports,
- Technical reports,
- Routine upload of STORET information, and
- Website enabled GIS maps for public access regarding impaired streams and lakes.

FUTURE GOALS

#	Goal
1	Improve and update website
2	Allow public access to data through the internet
3	Ensure that data submitted by volunteers meets minimum qualifications

CHAPTER 9 – PROGRAMMATIC EVALUATION

ADEQ's goal is to build the Water Quality Division's capacity to conduct periodic internal and external reviews of its water quality monitoring programs to determine if each program is meeting its stated goals.

CURRENT STATUS

- EPA and ADEQ conduct midyear and end of year evaluations of all program activities, including monitoring. These periodic reviews and discussions will continue in the future, and
- The biocriteria program was evaluated by Chris Yoder, a consultant for the EPA, and Robert Plotnikoff (Tetra Tech, Inc.) in August 2006. Chris provided critical feedback to strengthen the program including the recommendation to add a second biological assemblage and identifying midge larvae to the genus level.

FUTURE GOALS

#	Goal
1	Develop specific report cards for each program for evaluation
2	Develop and implement an information exchange program between AZ, CA, NV, CO, WY, UT, NM and the Arizona tribes to facilitate the exchange of ideas, to coordinate monitoring on a watershed level, to compare methodologies and to compare water quality between states
3	Contact other state monitoring programs to learn evaluation criteria for internal review and goal setting

CHAPTER 10 – GENERAL SUPPORT AND INFRASTRUCTURE

The successful implementation of a comprehensive monitoring strategy for the State of Arizona is dependent upon attracting and retaining qualified/experienced personnel along with adequate funding. ADEQ's current staffing and funding sources/level is outlined below.

CURRENT STAFF AND BUDGET

The Surface Water Section currently consists of five units. ADEQ currently has 10 full-time employees (FTEs) to monitor ambient streams, lakes, groundwater, wetlands, and perform TMDLS.

- Monitoring Unit (nine FTEs/five dedicated to ambient sampling),
- TMDL Unit (six FTEs/ five dedicated to TMDL sampling),
- Stormwater Permits Unit (six FTEs/ none dedicated to sampling),
- Permits Unit (13 FTEs/ none dedicated to sampling), and
- Water Quality Improvement Grants (four FTEs/ none dedicated to sampling)

ADEQ's monitoring budget for fiscal year 2010 was $1.9 million. This amount includes all personnel, contract and travel costs. Twenty-two percent of the 2010 monitoring budget is funded by the State of Arizona (Water Quality Assurance Revolving Fund, Clean Water Revolving Fund) while 78 percent is funded by federal money (performance partnership grant, 106 grant, non-point source, and the wellhead protection program funds) (Figure 10).

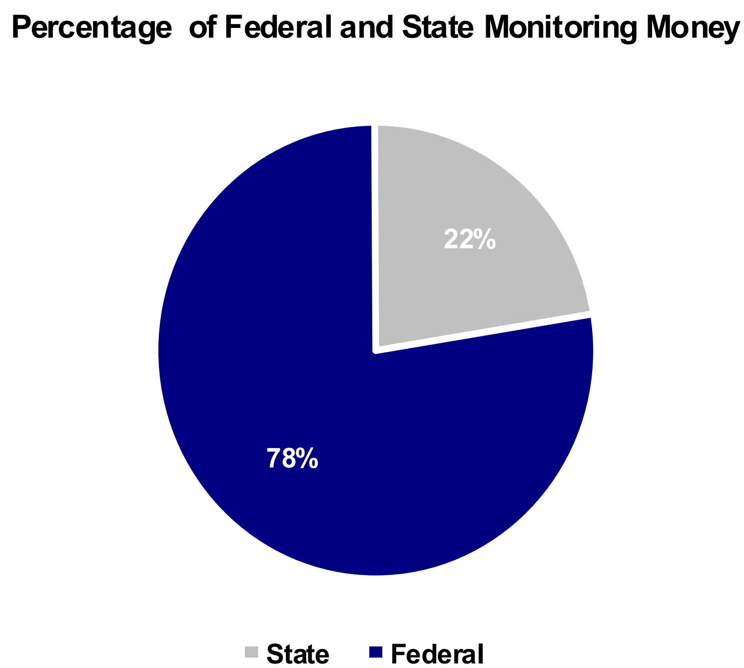


Figure 11. Percentage of state and federal funding for FY 10.

Approximately $250,000 of the budget goes toward laboratory costs while the rest is used for administrative costs such as staff salaries, vehicles, and computers. The laboratory budget is 71 percent lower than the 2007 budget of $870,000 due to Arizona's ongoing budget shortfall.

NEED FOR RESOURCES AND PEOPLE

Water quality monitoring data is the foundation on which all other water quality programs are built on. Assessments, standards, permitting, TMDLs, compliance and grants all rely on monitoring data. Water quality monitoring is a labor intensive and expensive process and unfortunately, the monitoring budget often suffers when budgets get tight. Tracy Mehan, a former assistant EPA administrator for water, put it this way.

> *Having served in state and federal government for nearly 15 years, I appreciate the immense challenges of funding and maintaining any kind of data collection, monitoring or assessment program over the long haul. When times are tough, these are the environmental programs which are often cut first. I have long believed that the exact opposite should be the case, i.e., they should be the last to be cut (Mehan, 2010).*

Adequate staffing and sufficient funds are two major factors that will determine the success of monitoring in Arizona. Table 7 summarizes the three levels of program development based on different staffing scenarios. Some other factors that need to be considered would be:

- Time needed to begin implementation,
- Staffing turnover rates,
- Comparable salaries,
- Career progression or monetary advancement within the agency, and
- Other Water Quality Division and agencywide priorities.

Table 7. Program Level development table.

Program Level	Staffing	Budget	Program Development
Basic	Bare minimum	Low	Services maintained. Program development can happen, but takes a longer time.
Intermediate	Adequate	Average	Some parts of the program move forward. Program development occurs a little faster.
Advanced	Optimal	High	Programs respond quickly to new regulations and ideas.

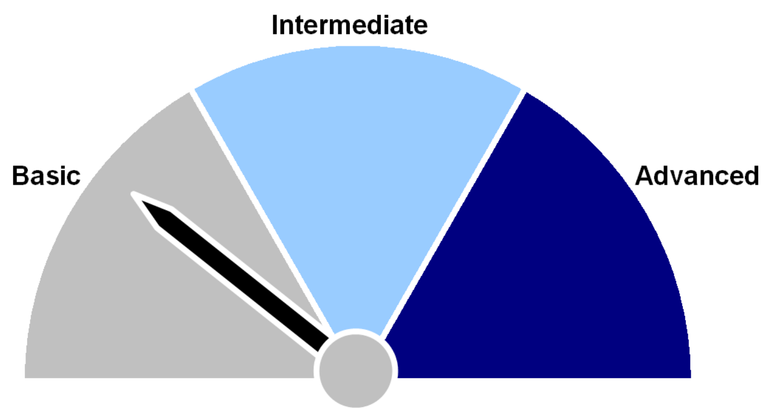


Figure 12. ADEQ's monitoring programs are currently at the basic level.

Due to the current budget situation, ADEQ's monitoring programs as a whole are currently operating at the basic level (Figure 12). Field personnel have been hit especially hard. In 2007, ADEQ's Ambient Monitoring Program had eight staff dedicated to monitoring. This number was reduced to four field personnel in 2010. The four vacant positions are 'frozen' and cannot be filled at this time. The four remaining staff members are responsible for monitoring all of Arizona's lakes, streams, wetlands, and groundwater. Put another way, ADEQ's ambient monitoring is limited to one person per waterbody type (groundwater, streams, lakes, and wetlands). Four people simply aren't enough to effectively monitor the sixth largest state in the country.

The TMDL Unit currently has five staff members whose primary responsibilities include developing and monitoring the effectiveness of the TMDLs. Two staff members develop stream TMDLs, two develop lake TMDLs while the additional staff member conducts TMDL effectiveness monitoring. Historically the unit had an additional five field staff but these positions are vacant due to voluntary separations and a hiring freeze. One staff acted as the TMDL watershed coordinator, interacted with watershed groups and developed TMDL implementation plans. The unit lost three staff that primarily developed stream TMDLs. Finally, the unit also lost the Colorado River specialist who was working on Colorado River TMDLs and represented the agency at meetings regarding the river. The loss of staff has slowed the development of TMDL implementation plans, Colorado River TMDLs, and several stream TMDLs (Santa Cruz, Nogales Wash, Mule Gulch, Pinto Creek, etc). Additionally, the ability to sample many projects ongoing concurrently has diminished. Future work plans with be scaled down with fewer new TMDLs being developed and ultimately completed each fiscal year.

ADEQ's ability to attract and retain experienced staff is a continuing challenge due to salary and career constraints. Starting salaries are fairly good at ADEQ, but the lack of career ladders and raises that exceed inflation rates result in a high staff turnover rate.

At the current level of resources ADEQ has been able to assess three percent of Arizona's streams (2006/08 Assessment), 30 percent of Arizona's lakes (2006/08 Assessment), and approximately two groundwater basins per year (out of 51 basins in Arizona). Notwithstanding the obstacles, ADEQ has managed to develop several key programs, one of which is the biocriteria program.

FUTURE GOALS

#	Goal
1	Provide training/growth opportunities, and a supportive work environment to retain qualified staff
2	Provide salaries that are comparable to other water quality professionals
3	Create a career path that provides financial rewards to valued staff

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APPENDIX A – IMPLEMENTATION SCHEDULE

The following table summarizes and prioritizes the areas that could be improved for each of the 9 elements. The time frame assumes that the identified resource needs have been met. Resources are categorized in three major groups: Time, money, and people.

#	Goal	Implementation Plan	Priority	Resources Needed	Time Frame
Monitoring Design – Chapter 3					
1	Conduct additional special studies, such as impacts from wildfires to lakes and streams	Determine and prioritize special study needs and objectives.	Medium	People, time and money	As needed
2	Coordinate with tribes, states, and Mexico when monitoring and research goals overlap	Facilitate communication between water quality staff in different states, tribes and Mexico.	High	People and time	On-going
3	Increase number of samples for the stream, lakes and groundwater programs to improve confidence in data evaluation.	Determine optimal number of samples to provide statistically valid results.	Medium	People, time and money	FY 2012
4	Monitor wetlands	Develop wetland monitoring protocols and QAPP. Identify wetlands and develop Geographic Information System wetland map. Develop appropriate monitoring design. Coordinate with other state and federal agencies.	Low	People, time and money	On-going
5	Monitor Effluent Dependent Waters (EDWs)	Develop EDW monitoring protocols and QAPP. Identify EDWs and develop Geographic Information System map.	Medium	People, time and money	On-going

#	Goal	Implementation Plan	Priority	Resources Needed	Time Frame
6	Address assessment data gaps identified on Arizona's 2004 §305(b) report	Monitor 60 to 70 assessment units per year (At current staffing levels). ADEQ plans to continue to use a targeted monitoring design and to schedule monitoring of planning list sites according to the ADEQ 5-year watershed monitoring schedule.	High	People, time and money	On-going
7	Identify midge specimens to the genus level	Reassess current IBI scores using midge data.	Medium	Time	On-going
8	Increase size of groundwater monitoring program	Increase number of dedicated groundwater monitoring staff. At the current rate of monitoring ADEQ will complete the sampling and present findings for each of the 51 groundwater basins by approximately 2028.	Low	People and money	FY 2012
9	Increase the use of trend analysis in the groundwater monitoring program	Develop a probabilistic approach similar to the rotating basin to monitor wells in a cyclical pattern over time.	Medium	Time	FY 2011
10	APP effectiveness monitoring program	Map existing points of compliance and evaluate permit effectiveness statewide	Medium	Time	FY 2011
11	NPS effectiveness monitoring	Evaluate effectiveness of watershed improvement grants on NPS discharges	Medium	Time	FY 2011
12	Use sensors or remote monitoring devices to more efficiently collect data	Deploy remote monitoring devices such as rain gauges and multiprobes to collect real time data.	Medium	Money	FY 2012
13	Monitor intermittent streams	Deploy pressure transducers to approximately 10 intermittent sites. Collect macroinvertebrate data to assess the applicability of the macroinvertebrate Index of Biological Integrity to intermittent streams	High	People, time and money	FY 2011

#	Goal	Implementation Plan	Priority	Resources Needed	Time Frame
14	Monitor geomorphological condition of wadeable perennial streams	Collect geomorphological data such as relative bed stability for each stream type in Arizona as defined by Rosgen 1996. Analyze data and determine if a standard can and should be developed for physical integrity.	High	People, time and money	FY 2011
Core and Supplemental Indicators – Chapter 4					
15	Develop narrative standards for toxics	Write rule. Write implementation procedures.	High	Time	FY 2012
16	Monitor for emerging contaminants	Hire or contract a specialist in emerging contaminants preferably with a background in toxicology.	Low	People and money	FY 2013
17	Add second biological assemblage for stream assessments	Identify proper assemblage (fish, algae, etc.) develop index of biological integrity based on reference conditions.	Medium	Time	FY 2013
18	Compare and assess Arizona indicators compared to other states, tribes and Mexico	Coordinate with other regions to determine indicator similarities and differences	Medium	Time	FY 2011
19	Refine narrative standards for nutrients and bottom deposits	Assess standards based on new information.	Medium	Time	On-going
Quality Assurance – Chapter 5					
20	Draft a QAPP that covers all Surface Water Sampling	Follow QAPP document	Completed in 2007		
Data Management – Chapter 6					
21	Define the geographic location of assessment units using the National Hydrography Dataset (NHD)	Coordinate with IT to complete task.	Medium	People, time and money	On-going
22	Follow data standards for digital geospatial metadata to label geospatial datasets	Coordinate with IT to complete task.	Medium	People, time and money	On-going

#	Goal	Implementation Plan	Priority	Resources Needed	Time Frame
23	Develop a data entry portal for outside data to be entered for assessment purposes	Integrate credible data rules into database. Allow for integration with WQDB.	Low	People, time and money	FY 2017
24	Develop modules within WQDB to house time series data	Work with IT to complete task.	Low	People, time and money	FY 2017
25	Update and enhance AZAC	Work with IT to complete task.	High	People, time and money	On-going
Data Analysis and Assessments – Chapter 7					
26	Develop criteria and guidance to include volunteer monitoring results in assessments	Work with universities, community colleges, the Master Watershed Steward Program, and other volunteer groups to gather quality water monitoring data.	Medium	Time	FY 2012
Reporting – Chapter 8					
27	Improve and update website	Make the website current. Include updated sample plans, reports and non-technical description of the water quality of the state.	Medium	Time	On-going
28	Allow public access to data through the internet	Work with IT to complete the mapping of the Water Quality Database to the WQX schema to allow current ADEQ data to be displayed on EPA's STORET website.	Medium	People, time and money	FY 2011
29	Ensure that data submitted by volunteers meets minimum qualifications	Hire volunteer coordinator. Ensure that volunteer data is accurate and that they are following established minimum procedures.	Low	People, time and money	On-going
Program Evaluation – Chapter 9					
30	Develop specific report cards for each program for evaluation	Report cards will be used to measure program effectiveness based on specific criteria.	High	Time	FY 2012

#	Goal	Implementation Plan	Priority	Resources Needed	Time Frame
31	Develop and implement an information exchange program between AZ, CA, NV, CO, UT, NM, WY and the Arizona tribes to facilitate the exchange of ideas, to coordinate monitoring on a watershed level, to compare methodologies and to compare water quality between states	Meetings/workshops through Western States Water Council.	Medium	Time	FY 2012
32	Contact other state monitoring programs to learn evaluation criteria for internal review and goal setting	Communicate directly with monitoring management from other states to determine what evaluation criteria they use.	Medium	Time	On-going
General Support and Infrastructure – Chapter 10					
33	Provide training/ growth opportunities, and a supportive work environment to retain qualified staff	ADEQ can strive to provide training/growth opportunities, and a supportive work environment for program staff to support retention.	High	People, time and money	FY 2011
34	Provide salaries that are comparable to other water quality professionals	Salary increases limited by actions of state legislature. ADEQ can work to increase the number of 'steps' for the EPS and Hydrologist classifications.	High	Money	FY 2011
35	Create a career path that provides financial rewards to valued staff	Salary increases limited by actions of state legislature. ADEQ can work to increase the number of 'steps' for the EPS, Hydrologist and Supervisor classifications.	High	Money	FY 2011